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Studies of Lythrum Salicaria—II*
A new form of flower in this species

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(WITH SIX TEXT FIGURES)

The purple loosestrife, *Lythrum Salicaria* L., has long been known as one of the relatively few species of plants that are trimorphic. That is, the species includes individuals having flowers of three different types. Named with respect to the three lengths of pistils, there are the *long-styled* flowers (see FIG. 5) with a set of long-stamens and a set of short-stamens (enclosed within the calyx and not shown in the picture), the *mid-styled* flowers (FIG. 2) with a set of long-stamens and a set of short-stamens, and the *short-styled* flowers (FIG. 1) with a set of mid-stamens and a set of long-stamens. There is thus one of the three kinds of pistils and two different sets of stamens in each flower. All flowers on a plant are alike. The species includes three groups of individuals or *forms* in regard to the relative length of pistils and stamens as shown in FIGS. 1, 2 and 5.

Students of this species have noted minor variations in respect to structure, size, color, and inter-relations in fertilization among pistils and stamens. All have, however, evidently experienced no special difficulty in grouping the plants which they studied into the three forms generally recognized. No distinctly new form or modification of the old forms seems to have been found. But in a culture of this species recently grown at the New York Botanical Garden, noticeable variations have appeared and one type of flower is sufficiently frequent to be recognized as a new form.

In this new form (see FIGS. 3, 4 and 6) the pistil and the set

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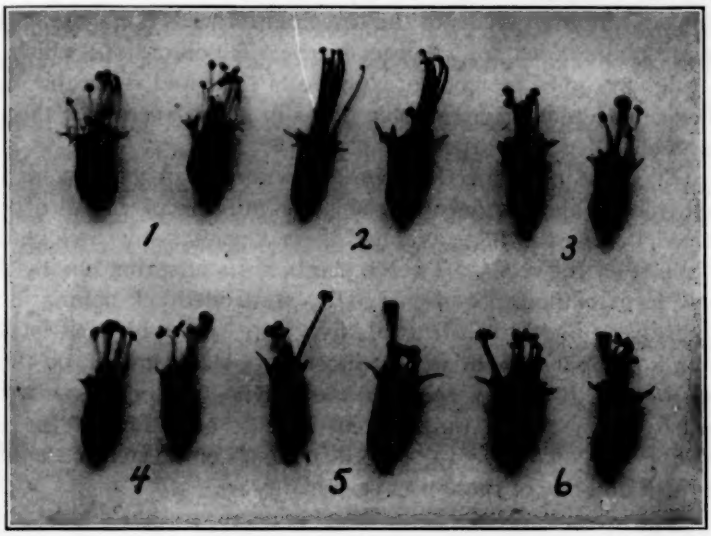
of longer stamens are almost of equal length and this length is about midway between the two lengths characteristic of the mid- and the long-lengths as seen in long- and in mid-styled plants. It is to be noted that the long stamens of the short-styled form (FIG. 1) are as a rule somewhat shorter than are the long stamens of the mid-styled form (FIG. 2). The stigmatic lobes of the pistils of the new form are as large or even larger than those of long-styled plants and considerably larger than the stigmas of mid-styled plants (compare FIGS. 3, 4 and 6 with 5 and 2). The new form may be considered as homomorphic for the lengths of the pistil and the set of longer stamens but there is also a set of short stamens so it may be designated as a semi-homomorphic form.

The first plant having flowers of this new type appeared among the self-fertilized progeny of a mid-styled plant. The other 58 sister plants of this particular series were either mid-styled or long-styled with no marked deviations in lengths of parts from those typical for these forms. This plant was selfed by the bagging method in the first year of its bloom and found to be highly self-compatible. It was then removed to my home garden at Pleasantville, New York, where it was grown in isolation from any other plant of *Lythrum*. It produced seed in abundance to the enforced self-pollinations and from such seed 122 plants have been grown to blooming age, and for many of these, observations on flower character have been made for three years. Of these plants, 60 were readily to be classed as of the new semi-homomorphic form, nine were long-styled, 52 were intermediate between the new form and the long-styled and one plant was mid-styled. The intermediates varied toward the long-styled form in that the pistil was longer than the stamens; there were none that varied toward the mid-styled form.

Mention should be made of the wide variations in the color of anthers in the flowers of these plants. The anthers of long stamens and the pollen which they contain are typically dark colored or purplish, sometimes described as greenish, while the anthers and pollen of short- and mid-stamens are yellow. It has, however, frequently been observed that some of the mid-stamens of long-styled plants may be dark in color.

In the first plant of the new form the various members of the longer set of stamens were quite uniform as to length, but purple

and yellow anthers were intermingled, with the yellow predominating. For most of the 122 plants, the offspring of this first semi-homomorphic plant, the anthers of the *longer set of stamens* were much mixed in color. The summary for the entire series is as follows. For the one mid-styled plant these anthers were uniformly all dark. For the nine long-styled plants, seven had



FIGURES 1-6. Flowers typical for the four forms in the one species *Lythrum Salicaria*. The three older forms are the *short-styled* (1), the *mid-styled*, (2) and the *long-styled* (5). Flowers of the new and *semi-homomorphic* form are shown at 3, 4 and 6; the anthers of the longer set of stamens are all purple in 6, all yellow in 4, and yellow or purple intermingled in 3. The short stamens and pistils are, except in a few cases, entirely enclosed within the calyx. The magnification is almost two times natural size.

only the yellow anthers typical of this form and two had colors intermingled. For the 60 plants of the new form, the long stamens of six were wholly dark (see FIG. 6), 25 were wholly yellow (see FIG. 4) and for 29 there was a mixture of both colors. For the intermediates, only dark stamens were found for six, only yellow for 21, leaving 25 with the colors intermingled. For a large number of plants in this series, the color of the longer set of stamens was highly variable. The relative number of dark and yellow stamens varied greatly for different individuals; it

varied among flowers open on the same day, and it varied from day to day.

Naturally the question arises as to whether plants of the new form are highly self-compatible, or are more decidedly or more uniformly so than are plants of the old form. In them, self-pollinations from pollen of the longer set of stamens are "legitimate." Legitimate pollination is not possible in self-pollinations of any individuals of the three old forms. For them, legitimate pollinations are all inter-form cross-pollinations which as a rule appear to be more productive of fruit and seeds than are illegitimate self- or cross-pollinations in accordance with the results obtained by Darwin (1865 and 1877).

The first plant of the semi-homomorphic form was highly self-compatible not only in the large number of capsules produced but in the high average of seed per capsule and in the viability of the seeds. Twelve plants of its offspring having the new form of flower were tested by controlled self-pollinations; three were highly self-fruitful, five were somewhat self-fertile, and four appeared to be self-incompatible. Another of these plants was grown in isolation and it yielded fine capsules for nearly every flower that bloomed. But also four of the six plants with intermediate flowers which were tested were self-fruitful and one of these was very highly so.

The semi-homomorphic form appears to be highly self-fertile, but the degree varies for individual plants and some are self-sterile. This condition has also been found (Stout, 1923) for other forms and especially for the mid-styled form. The new form appears from the data at hand to be at least as highly self-fruitful as is the mid-styled form.

The appearance of only one plant of the new form among a considerable number of plants together with the fact that this form has not been reported previously suggests a mutation. Its form of flower re-appears in a considerable number of its offspring, so there is an hereditary value to the new character. It does not immediately breed true, so the new form is not at first homozygous.

The new form presents a correlated modification of both the pistil and at least one set of stamens. In the size of the stigmatic lobes there is decided resemblance to the long-pistils; the lengths of both pistil and stamens are modified; in the color of

anthers there is variation between the color of long-stamens and that of mid-stamens, with many, all of the same length, that have the colors intermingled. It may also be stated that this particular series of plants has shown variations in the number of petals of flowers, giving in extreme cases, plants entirely apetalous, a condition not observed thus far for any other culture.

Just what genetical changes are involved in the development of the new form can be determined further only by continued line breeding and by the character of progeny of crosses with the other forms. The large number of intermediates ranging toward the long-styled form suggests a relationship between this form and the mid-styled form from which the new form arose. The semi-homomorphic type of flower, is perhaps a reversion toward a simpler homomorphic type of flower which was without doubt the ancestral type of the species.

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Anomalies in maize and its relatives—II
Many-flowered spikelets in maize

PAUL WEATHERWAX

(WITH FOUR TEXT FIGURES)

The spikelets of maize, like those of its nearest relatives in the tribes Tripsaceae, Paniceae, and Andropogoneae, are structurally two-flowered. The primordia of the two flowers appear in early stages of the development of the spikelet, but the subsequent abortion of parts gives rise to various types of mature spikelet in the different genera, or even in different inflorescences of the same individual. Of the two flowers in a spikelet, the upper is regularly the more advanced in development.

Although the floral structures of maize are characterized by a high degree of variability, this is usually a quantitative matter, concerning only the degree of development or of suppression of parts. But a variation that the writer has recently observed seems to involve a structural change of a more fundamental nature, in that the rachilla of the spikelet is often much more complex, the number of flowers in a spikelet is more than two, and the order of development of the flowers is reversed.

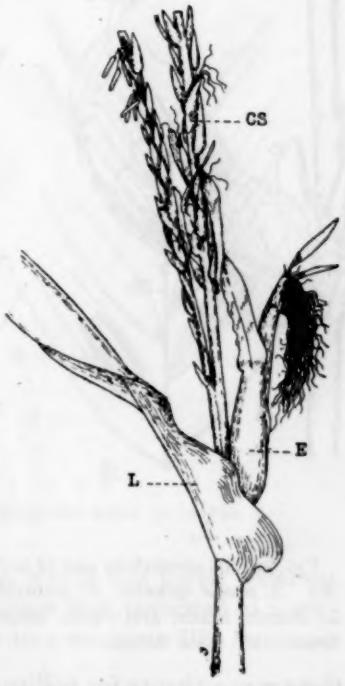

FIG. 1. Terminal inflorescence showing the anomalous spikelets. *L*, uppermost foliage leaf; *CS*, central spike, in the region of the anomalous spikelets; *E*, ear-like modification of a spikelet.

Details of the ancestry of the strain in which the anomaly was found are known only in part. Seeds expected to throw 25 per cent dwarf plants were received from Dr. R. A. Emerson

in 1917. This variety has been maintained since then by keeping seed from open-pollinated dwarf plants grown in proximity with their tall half-sisters and other varieties, none of which were dwarfs. In this way a number of homozygous (dwarf) plants could always be had, and the influence of other varieties was eliminated. In 1922, the year before the anomaly appeared,

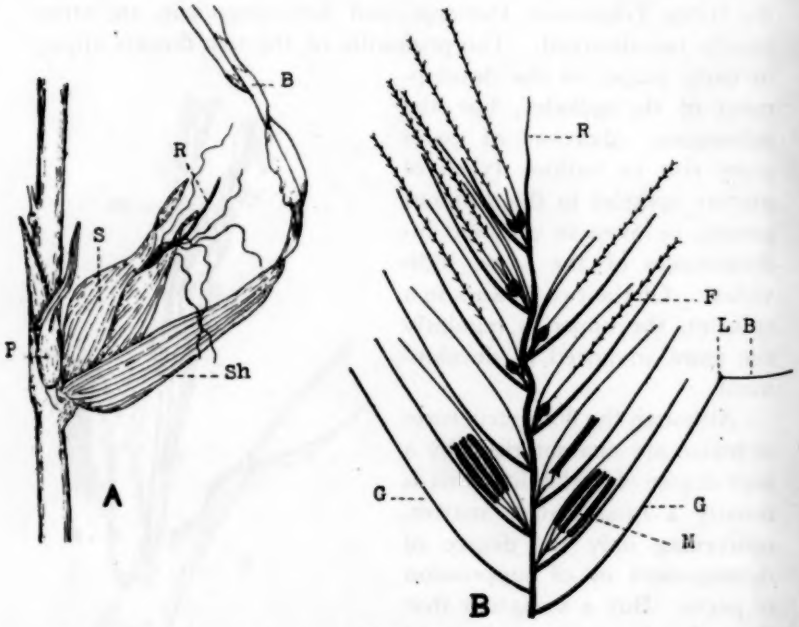

FIG. 2. An anomalous pair of spikelets (A), and the same shown in diagram (B). *S*, sessile spikelet; *P*, pedicelled spikelet; *R*, rachilla; *Sh* (or *G*), *B*, and *L*, sheath, blade, and ligule, respectively, of the lowest glume; *F*, female flower; *M*, male flower.

there was a chance for pollination of the dwarfs with the Chinese waxy variety, a fact which may be significant, in view of the latter's behavior in some crosses (**2**).

Of fifteen tall plants grown in 1923 from seed grown on a dwarf plant the preceding year, seven showed variously modified spikelets in their tassels. Some of these immediately attracted attention because of their unusual size, and by having three or more protruding silks in many cases. The reversal of sex in maize flowers is sufficiently frequent that a single occur-

rence would have little significance, but two is the maximum number of silks that could be expected from a spikelet unless it had more than two flowers. Dissection of a number of these spikelets showed in most cases more than the two normal flowers, as well as other interesting anomalies.

A typical individual showing the anomaly was selected for detailed examination. This plant bore in the normal position a rudimentary pistillate branch, which did not develop functional

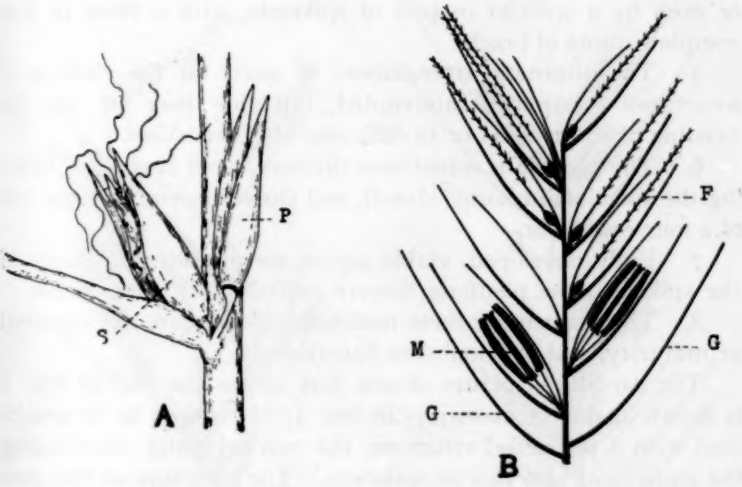

FIG. 3. Another pair of spikelets. Legend the same as in FIG. 2.

flowers. The terminal inflorescence, which was barely exserted from the sheath of the uppermost foliage leaf, consisted of a central spike, a single lateral branch, and a small ear-like structure (FIG. 1).

The many-flowered spikelets occurred on the lower part of the central spike of this tassel. In most cases examined, it was the sessile spikelet of the pair that was modified, but in some instances where the sessile spikelet was extremely modified, the pedicelled member also showed an increase in number of flowers.

Two pairs of spikelets are shown in FIGS. 2, A, and 3, A, and their sessile members in diagram in FIGS. 2, B, and 3, B. The following general peculiarities are noted in these and in other spikelets dissected:

1. The two lowest bracts (glumes) in each spikelet are empty. They may bear ligules and leaf-blades.

2. The lower flowers in the spikelet are the more advanced in development, and the rachilla may be prolonged beyond the uppermost flower (FIG. 2, A and B).

3. The lowest flowers tend to be staminate and the upper pistillate. Between the two kinds may occur more or less incomplete male flowers, or empty lemmas accompanied by paleas.

4. The pistillate flower may be replaced by a pair of flowers, or even by a spikelet or pair of spikelets, with a more or less complete quota of bracts.

5. The alternate arrangement of parts on the rachilla is sometimes apparently interrupted, but this may be due to twisting of the rachilla or to difficulty of observation.

6. The rachilla is sometimes thickened and hardened, bearing the spikelets in horny alveoli, and closely resembling the cob of a four-rowed ear.

7. Fully developed, viable grains are produced in many of the spikelets, the pistillate flowers probably all being fertile.

8. The stamens in these modified spikelets are not exserted at maturity, and are doubtless functionless.

The ear-like structure shown just above the leaf in FIG. 1 is shown again (at maturity) in FIG. 4. It is seen to be associated with a pedicelled structure, the two evidently constituting the equivalent of a pair of spikelets. The structure of this pair (FIG. 4, B and C) shows only a more pronounced expression of the anomaly shown in the preceding cases.

The pedicelled member is a large, normal, staminate spikelet, except that it has three flowers. Here, as in the preceding cases, the stamens are probably functionless.

The sessile member is much like those shown in FIGS. 2 and 3 except in degree of modification. Its bracts are all large and husk-like. One glume and one lemma bear ligules and blades. One lemma subtends a short, rudimentary pistillate spike instead of a flower. Another subtends a pair of pistillate spikelets, each having a full quota of bracts and the aborted lower flower. The rachilla terminates in a well-developed eight-rowed ear, 9 cm. in length. Its two lowest pairs of grains are subtended by the two uppermost, large, well-developed, husk-like lemmas of the spikelet.

Kempton (2) has discussed the phylogenetic significance of

small ears similar to that shown in FIG. 4, which occurred at the base of the tassel in his hybrids involving the Chinese waxy variety and a dwarf (brachytic) strain. But he regards such ears as derivatives of lateral branches of the tassel.

Two or more of the plants of this anomalous population had staminate spikelets whose bracts were in several instances more than 10 cm. long and distinctly leaf-like. In external appearance these spikelets resembled those of the viviparous type figured and described by Collins (1)*. Although they bore male flowers

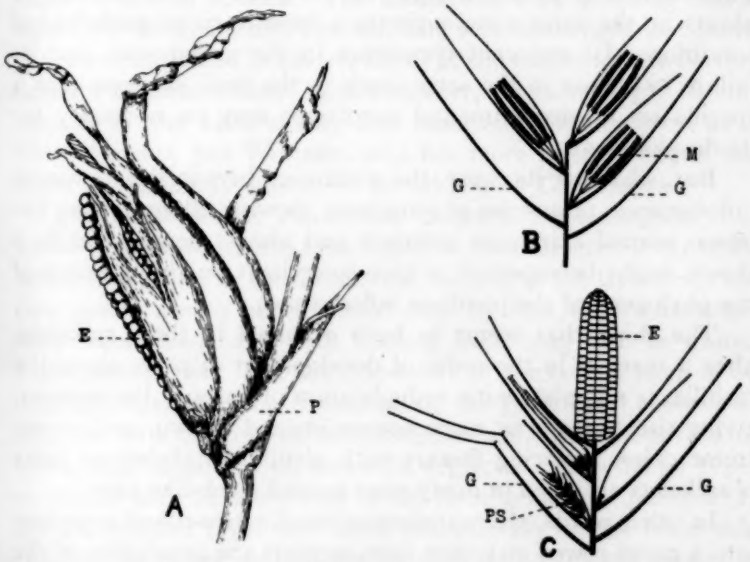

FIG. 4. Another pair of modified spikelets (A), and the pedicelled (B) and sessile (C) members shown in diagram. *E*, the sessile spikelet, the ear-like structure shown in FIG. 1; *P*, the pedicelled spikelet; *G*, glume; *M*, male flower; *PS*, pistillate spike.

in their lower portions, their indeterminate nature was evident from the prolonged or embryonic terminal portion of the rachilla. None of the spikelets put out any roots, however, as did those described by Collins.

* Collins regards this as a case of apogamy, but it is not at all a parallel of what usually passes under this term. The case that he describes seems to differ in no way from ordinary vivipary, which has been reported in a number of grasses.

The cause of the anomaly is not evident from the data now at hand. It was impossible to self-pollenize any of the plants in 1923, but seeds were produced by open pollination. A greenhouse generation, grown in the winter, showed an apparent recurrence of the anomaly, but the plants were otherwise so modified by the reduced illumination that the results were not dependable. Seeds from the ear shown in FIG. 4 were planted in 1924, but only normal plants were produced. Some of these were selfed, and the characteristic may appear again in the next generation if it is hereditary. Its occurrence in a number of plants at the same time suggests a hereditary or pathological condition. Its apparent recurrence in the greenhouse, and its failure to appear in the same stock in the field, suggests that a specific set of environmental conditions may be necessary for its development.

But, whatever its cause, the occurrence here in the staminate inflorescence, of a series of structures showing all gradations between normal staminate spikelets and almost perfect pistillate shoots might be expected to give some light on the question of the phylogeny of the pistillate inflorescence.

The thing that seems to have occurred in these spikelets, after a reversal in the order of development of parts along the rachilla, is a meristematic reduplication of parts in the spikelet, giving rise to three or more flowers instead of two, and, in extreme cases, replacing flowers with pistillate spikelets or pairs of spikelets arranged in many rows around a cob-like axis.

In other words, the transformation of a two-rowed structure into a many-rowed structure here suggests the possibility of the same occurrence, phylogenetically, in the development of the polystichous axes in the tassel and the pistillate inflorescence from the distichous ancestral form. This is another evidence that it is unnecessary to assume the lateral fusion of spikes to explain the origin of the ear. It does not at all follow from this that the ear is a phylogenetic descendant of the spikelet.

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2. **Kempton, J. H.** A brachytic variation in maize. U. S. Dept. Agr. Bull. 925: 1–28. *f. 1–8 + pl. 1–19.* 1921.

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Studies on the flora of northern South America—IV*

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THE GENUS BURMEISTERA

In 1856 Karsten and Triana established the genus *Burmeistera* to include certain green-flowered, baccate Lobeliaceae of Colombia, and Karsten at the same time published very brief descriptions of several species. The genus was very properly maintained by Bentham and Hooker, but was submerged in *Centropogon* by Schönland in his treatment of the family for the Natürlichen Pflanzenfamilien. Zahlbruckner, an exceedingly careful student of the Lobeliaceae, also maintained *Burmeistera* as a distinct genus, but Wimmer, who has more recently begun the study of the family, has again united it with *Centropogon*.

The chief generic distinction between *Siphocampylus* and *Centropogon* has hitherto been found in the character of the fruit, which is capsular in the former and baccate in the latter. If the two genera are to be separated only by this single character, then *Burmeistera*, also with baccate fruit, may well be united with *Centropogon*. But the characters of the corolla seem to be of great importance in distinguishing the genera of Lobeliaceae, and the structure of the anther-appendage, while doubtless of less weight, should by no means be neglected. Five major types of corolla may be discovered in the three genera in question:(1) the *Burmeistera* type, cleft much more deeply on the lower side than on the upper, so that the strongly deflexed lobes appear to be inserted at different heights; (2) the *Centropogon* type, with stout tube, frequently conspicuously bent, and relatively broad, falcate, strongly depressed lobes; (3) the *Siphocampylus* type, with straight slender tube, and relatively narrow, straight or spreading lobes; (4) the *Byrsanthes* type, with short, broad, nearly regular, campanulate tube and short, triangular, erect lobes; and (5) the type of *Siphocampylus radiatus*, with short, broad tube and long, more or less falcate, strongly deflexed lobes. Certain other minor types also exist, but intermediate forms apparently do not occur.

* Contributions from the New York Botanical Garden, no. 269.

In *Burmeistera* the two lower anthers are unappendaged. In *Centropogon* and *Siphocampylus* the appendage may consist of a mass of soft crooked hairs, of a tuft of straight, stiff, erect hairs, or of similar hairs concrescent into a flat triangular scale. All of these are represented in *Centropogon*, which is thus seen to be a heterogeneous mixture as to anthers, just as *Siphocampylus* is a mixture as to corolla. The character of the fruit, which is now the sole distinction between two of the genera, does not appear to be constant and certainly does not merit the importance which has been attached to it. Most specimens in herbaria are without fruit and many species have been described without the fruit being seen, yet any of them may be assigned easily and accurately to their proper place by the character of the corolla and anthers alone.

The scope of a genus depends, of course, entirely upon personal opinion. No one can speak *ex cathedra*, defining the extent of any genus or specifying what characters are to be used in generic segregation. Yet anyone who examines a series of plants of this group will observe as great structural differences within the single genus *Siphocampylus* as between any part of it and the genus *Centropogon*. If the existing and easily observable characters are given proper consideration, but two courses are logically available. If the various types of corolla and of anther-appendage are not regarded as of generic value, then *Burmeistera*, *Centropogon*, and *Siphocampylus* should be united into one vast genus. If they are of generic value, at least five genera should be recognized instead of three. The former course is at variance with current usage and current taxonomic practice, and either of them would necessitate, if adopted, the alteration of scores of binomials, thereby adding permanently to an already unwieldy synonymy and affecting the names of numerous species now in horticultural trade. Taxonomists would be well advised to avoid throwing any of their burden of synonymy upon those who use plants or upon those engaged in other lines of botanical activity.

From a practical standpoint it has seemed more desirable to pursue a middle course and maintain the three genera of long standing, while recognizing that two of them are polymorphic groups and might easily be segregated. The result of this treatment is seen in the facts that only one transfer of name is re-

quired and only two double citations appear among twenty-two species.

The center of distribution of *Burmeistera* is the Andes Mountains of Colombia. The genus extends thence south to Peru, east into the Andes of western Venezuela, and north, well into Central America, always at a considerable altitude. The lowest altitude noted on our specimens is 1400 meters, the highest 3000 meters. The species are herbs or shrubs, apparently varying with the size or age of the individual, and a few have been noted as climbing. Since they are not known to twine or produce true holdfast roots, they probably merely recline against the branches of shrubs or trees above them, or take root in moist crevices of the bark.

Seventeen species are known to me from northern South America, and may be distinguished by the key below. Five others have been described but have not been seen by me, while at least five other well-marked but undescribed species are conserved in various European herbaria. In the citation of specimens, the various herbaria are indicated as follows: (G) Gray Herbarium of Harvard University; (K) Royal Botanic Garden, Kew, England; (P) Muséum d'Histoire Naturelle, Paris, France; (W) National Herbarium, Washington, D. C.; (Y) New York Botanical Garden. I have also seen the types of several of Zahlbruckner's species, on loan to the Royal Botanic Garden at Kew.

1. Hypanthium during anthesis obconic to cylindric, conspicuously narrowed to the base, longer than wide when pressed.
   - Leaves lanceolate, long-acuminate to the sharp tip.
     - Sepals triangular, acute, separated by narrow acute sinuses; leaves glabrous beneath, the lateral veins strongly ascending and almost parallel to the midvein. . . . . 1. *B. Weberbaueri*
     - Sepals linear or linear-oblong, obtuse or rounded, separated by rounded sinuses; leaves pubescent beneath, the lateral veins widely spreading.
       - Sepals 10–13 mm. long, exceeding the hypanthium; leaf-pubescence of straight white hairs. . . . . 2. *B. truncata*
       - Sepals 3–4 mm. long, shorter than the hypanthium; leaf-pubescence of long (0.5 mm.) brownish hairs on the veins and of minute brown hairs on the surfaces. . . . . 3. *B. longifolia*
   - Leaves oblong to ovate, abruptly narrowed to a cuspidate tip, acute or obtuse.

Sepals as broad as long and not exceeding 2.5 mm. in length .....
Leaves sharply and prominently callous-dentate, the lateral veins connected into a prominent marginal vein paralleling the margin at a distance of 2 mm. and strongly elevated beneath ..... 4. *B. marginata*
Leaves barely denticulate to entire, the lateral veins not connected into a prominent elevated intramarginal vein.
Sepals acute; leaves oblong or oblong-lanceolate, obtuse at the apex of the cusp ..... 5. *B. cylindrocarpa*
Sepals broadly rounded; leaves ovate or ovate-oblong, sharply acute ..... 6. *B. glauca*
Sepals linear or oblong, notably longer than broad.
Sepals 2.5–4 mm. long.
Sepals 1 mm. wide, entire; leaves narrowed to the base ..... 8. *B. crispiloba*
Sepals 1.5–2.5 mm. wide, frequently crenate; leaves obtuse or rounded at the base ..... 9. *B. leucocarpa*
Sepals 12–25 mm. long ..... 12. *B. succulenta*

2. Hypanthium during anthesis subglobose or short-cylindric, rounded at the base.

Sepals ovate, varying to obovate or oblong, shorter than or barely exceeding the hypanthium, 2–4 mm. wide and rarely more than twice as long.
Leaves broadly round-ovate, thick and firm, strongly rugose above with deeply impressed veins ..... 13. *B. Killipii*
Leaves ovate to oblong or elliptic, thin, not rugose.
Leaves densely pubescent with minute hairs on the veins beneath.
Sepals 4–6 mm. long; leaves minutely denticulate ..... 14. *B. multiflora*
Sepals 12–14 mm. long; leaves sharply serrate. 15. *B. Pennellii*
Leaves glabrous beneath.
Leaves broadest above the middle, prominently denticulate, long-cuneate at base ... 16. *B. connivens*
Leaves broadest below the middle, entire or with minute intramarginal callosities, obtuse at base ..... 17. *B. glabrata*
Sepals linear, longer than the hypanthium, and usually more than three times as long as wide.
Leaves long-acuminate, usually coarsely repand-serrate ..... 19. *B. lacerata*
Leaves obtuse, acute, or abruptly cuspidate, the callosities almost entirely intramarginal.
Leaves thick and firm, broadly cuneate to subrotund at base, pubescent on the purplish, conspicuously reticulate veins beneath; intra-

marginal vein prominent; total length of flower about 25 mm ..... 21. *B. carnosa*

Leaves membranous, rounded to subcordate at base, glabrous; veins white beneath, faintly reticulate; intramarginal vein obscure; total length of flower about 40 mm ..... 22. *B. asclepiadea*

1. B. WEBERBAUERI Zahlbr. Bot. Jahrb. **37**: 451. 1906.

Peru: *Weberbauer 2203* (type), mountains east of Huacapistana, alt. 3200 m., Prov. Tarma, Dept. Junin; *2473; Lobb 377* (K); *Pearce* (K).

2. B. TRUNCATA Zahlbr. Repert. Spec. Nov. **13**: 531. 1915.

Ecuador: *Sodiro 91/23* (type), Quito Andes, on the descent from Canzacato to S. Florencio, Prov. Pichincha.

3. **Burmeistera longifolia** n. sp. Stem herbaceous, faintly striate, thinly puberulent with curved slender hairs nearly 1 mm. long, the internodes 1–2 cm. long; petioles 5 mm. long, puberulent, especially on the back; leaf-blades thin, dark-green, narrowly lanceolate, the largest 95 mm. long by 23 mm. wide, the upper gradually reduced to 28 mm. long, long-acuminate, subentire, broadly cuneate or obtuse at base, the veinlets somewhat enlarged and callous at the margin at intervals of about 1 cm., minutely puberulent above when young, scabrellate on the surface at maturity but persistently puberulent along the midvein, thinly pubescent on the veins beneath, lateral veins ascending; hypanthium broadly obconic, 7.5 mm. high, sparsely puberulent; sepals reflexed, narrowly oblong-triangular, 3.5 mm. long with 1 or 2 low callous crenations on each side, puberulent, obtuse, separated by broad rounded sinuses; corolla very sparsely puberulent, the straight tube 14 mm. long on the lower side, 20 mm. on the upper, the lower lobe 8 mm. long, 3 mm. wide, the lateral lobes broadly triangular, 8 mm. long, 6 mm. wide, acute, abruptly decurved at the apex, the upper lobes oblong-falcate, 13 mm. long, 4 mm. wide; filament-tube 37 mm. long, glabrous; anther-tube decurved, 5 mm. long, sparsely puberulent on the sutures, villous with short hairs at the tip.

Type, *Pennell 4399*, collected 7–11 Sept. 1922, in a forest above Cascada Chorron, south of Antizales, Dept. Bolivar, Colombia, alt. 2400–2700 m., and deposited in the herbarium of the New York Botanical Garden.

4. B. MARGINATA Karst. Linnaea **28**: 445. 1856.

Colombia: *Triana 1585* (type, P), vicinity of "Consota" in

Quindio, alt. 1350 m. (near Pereira, Dept. Caldas); *André 3439* (K).

5. B. CYLINDROCARPA Zahlbr. Repert. Spec. Nov. **13**: 533. 1915.

Ecuador: *Lehmann 192* (type), western slopes of Quito Andes near Angui, alt. circ. 1800 m., Prov. Pichincha.

6. **Burmeistera glauca** (Wimmer) n. comb.

Centropogon glaucus Wimmer, Repert. Spec. Nov. **19**: 251. 1924.

Panama: *Pittier 3219* (type, W), humid forest of Cuesta de las Palmas, southern slope of Cerro de la Horqueta, Chiriqui, alt. 1700–2100 m. Colombia: *Pennell 4440*, forest, Antizales, Dept Bolivar, alt. 1700–2000 m., 25, 26 Feb. 1918 (Y); *Pennell & Killip 5798*, forest above La Cumbre, Dept. El Valle, alt. 2000–2200 m., 14–19 May 1922 (Y); *Killip 11,394*, bushy summit of west peak, La Cumbre, Dept. El Valle, alt. 2100–2400 m., 11, 18 Sept. 1922 (Y); *Pittier 742*, Cuesta de Tocota, road from Buenaventura to Cali, western Cordillera, alt. 1500–1900 m., Dept. El Valle, Dec. 1905 (W).

7. B. SODIROANA Zahlbr. Repert. Spec. Nov. **13**: 534. 1915.

Ecuador: *Sodiro 91/25*, along Rio Pilatón, Prov. Pichincha, alt. 900–1600 m. Not seen: from Zahlbruckner's description apparently related to *B. glauca*.

8. B. CRISPILOBA Zahlbr. Repert. Spec. Nov. **13**: 528. 1915.

Ecuador: *Sodiro 91/24* (type), subtropical forest of the valley of Pallatanga, Prov. Chimborazo; *André* (K).

9. B. LEUCOCARPA Zahlbr. Repert. Spec. Nov. **13**: 529. 1915.

Ecuador: *Sodiro 91/21* (type), temperate forests near S. Florencio and Niebly, Prov. Pichincha; *Pachano 177*, Ambato, Prov. Tungurahua (Y, W); *Jameson 64, 645, 707*, all from Pichincha (K).

10. B. CERASIFERA Zahlbr. Repert. Spec. Nov. **13**: 532. 1915.

Colombia: *Lehmann 2934*, border of dense forests in the plain of the lower Rio Dagua, Dept. El Valle, alt. 100–300 m. Not seen: from the original description apparently related to *B. crispiloba*. The exceptionally low altitude of this species is noteworthy.

11. B. RESUPINATA Zahlbr. Repert. Spec. Nov. **13**: 530. 1915.

Ecuador: *Sodiro 91/20*, cliffs along Rio Pilatón, Prov. Pichincha, alt. 1000–1600 m. Not seen: from the original description apparently related to *B. leucocarpa*.

12. B. SUCCULENTA Karst. Linnaea **28**: 445. 1856.

Centropogon longipes Zahlbr. Ann. Naturh. Hofmus. Wien. **6**: 439. 1891.

Venezuela: Caracas, *Funck & Schlim 442* (P), *Linden 231* (K, P); vicinity of Colonia Tovar, *Fendler 731* (G, K, Y), *Pittier 9317* (W, Y); *Pittier 8120*, headwaters of Rivers Chichiriviche and Petaquire, Coastal Range, Federal District, alt. 1800–2000 m., 4 Sept. 1918 (W). Colombia: *Triana 1586* (type, P), "Mariquita Prov. Col." [probably Mariquita, Dept. Tolima]; *Holton* (Y); *Pennell 5151*, forest, La Cumbre, Dept. El Valle, alt. 1800–2000 m., 7–10 May 1922 (Y); *Pennell 10,685*, edge of woods, San Clemente, Dept. Caldas, alt. 1800–2200 m., 16 Sept. 1922; *Pennell & Killip 5783*, forest above La Cumbre, Dept. El Valle, alt. 2000–2200 m., 14–19 May 1922. Ecuador: *Jameson*, Quito (K); *Spruce 6212*, base of Mt. Chimborazo (K).

13. **Burmeistera Killipii** n. sp. Stem shrubby, finely striate, pubescent with scattered, flat, lanceolate, brown hairs, the internodes about 15 mm. long; petioles stout, 7 mm. long, channeled above, pubescent like the stem on the back; leaf-blades dull green, coriaceous, broadly ovate, 20–30 mm. long, 17–25 mm. wide, obtuse or subacute, broadly rounded or subcordate at base, minutely serrate with low, callous, ascending teeth 3–4 mm. apart, glabrous with deeply impressed, arcuately ascending veins above, sparsely pubescent beneath, especially on the prominent veins, with spreading crooked hairs nearly 1 mm. long; peduncles from the upper axils, stout, spreading, 10–15 mm. long, sparsely pubescent, becoming more densely pubescent toward the summit; hypanthium depressed-globose, 5 mm. long, pubescent with brown crooked hairs 0.5 mm. long; sepals firm, reflexed, obovate-oblong, 4 mm. long, 2.5 mm. wide, rounded at the apex, sparsely ciliate, glabrous on the surface; corolla-tube glabrous, 12 mm. long below, 18 mm. long above; corolla-lobes acute, strongly depressed, sparsely pubescent, the lower ovate-lanceolate, 6 mm. long, the lateral triangular-ovate, 6 mm. long, 4 mm. wide, the upper triangular-oblong, falcate, 8 mm. long, 4 mm. wide; androecium glabrous; filament-tube long-exserted, 38 mm. long; anther-tube 3 mm. long.

Type, *Killip 7980*, collected in the forest at "La Gallera," Micay valley, Dept. El Cauca, Colombia, alt. 2200–2500 m., 1 July 1922, and deposited in the herbarium of the New York Botanical Garden; *Pennell 7527*, shrub-zone, Mount El Trueno, Dept. El Cauca, alt. 2700–3000 m., 29–30 June 1922(Y).

14. B. MULTIFLORA Zahlbr. Repert. Spec. Nov. **13**: 530. 1915.

Ecuador: Quito Andes, *Jameson 542* (duplicate of the type, P); *André 3088* (K).

15. **Burmeistera Pennellii** n. sp. Stem apparently herbaceous, finely striate, pale green, sparsely pubescent when young with spreading white hairs 0.4 mm. long, becoming glabrous with age, the internodes 3–5 cm. long; petioles stout, compressed, 15–25 mm. long, pubescent like the stem; leaf-blades elliptic-oblong, thin and membranous, deep green, 18 cm. long, 7.5 cm. wide, the uppermost smaller, broadest about the middle, abruptly narrowed into a subacuminate or short-cuspidate tip, sharply denticulate with low, broadly triangular, callous teeth (about 3–4 teeth per centimeter of margin), acute at base, minutely puberulent on the surface above, more densely so on the midvein, softly pubescent on the veins and veinlets below with minute spreading hairs 0.4 mm. long, lateral veins widely spreading, nearly straight; peduncles from the upper axils, erect, strongly compressed, 8 cm. long, minutely puberulent; hypanthium subglobose, 9 mm. high, sparsely puberulent; sepals erect, narrowly ovate-oblong, 12–14 mm. long, 3–4 mm. wide, obtuse, sparsely puberulent, conspicuously ciliate, with about 6 pairs of callous, barely protuberant teeth; corolla sparsely puberulent, the tube 7 mm. long below, 15 mm. long above, the lobes narrowly triangular-falcate, the terminal 16 mm. long; filament-tube 23 mm. long, puberulent or subtomentose with yellow hairs; anther-tube glabrous, bright yellow, minutely villous at the orifice.

Type, *Pennell 12,119*, collected near the Rio San Rafael, below Cerro Tatama, Dept. Caldas, Colombia, alt. 2500–2700 m., 7–11 Sept. 1922, and deposited in the herbarium of the New York Botanical Garden.

16. Burmeistera **connivens** n. sp. Stem apparently herbaceous, faintly striate, glabrous to minutely scabrellate, the internodes about 3 cm. long; leaves membranous, dark green, obovate-oblong, 11 cm. long, 4 cm. wide, or the upper smaller, abruptly narrowed above into an acute or subacuminate tip, gradually attenuate at base into a poorly defined, winged petiole, sharply denticulate with low callous teeth (3–4 teeth per centimeter of margin, 0.5 mm. high), glabrous, or with a few slender hairs on

the veins beneath, the lateral veins arcuately ascending, the veinlets conspicuously reticulate beneath; peduncles from the upper axils, slender, compressed, glabrous, 4–5 cm. long; hypanthium short-cylindric, 4–5 mm. high, 3–4 mm. wide when pressed, glabrous, rounded at the base; sepals erect, firm, ovate-oblong, 6 mm. long, 3 mm. wide, obtuse, conspicuously crenulate, somewhat narrowed to the base, glabrous, separated by narrow, acute sinuses; corolla essentially glabrous, about 20 mm. long; filament-tube puberulent, 35 mm. long; anther-tube glabrous, minutely villous at the orifice, 7 mm. long.

Type collected by *Lehmann* in the central Andes of Popayán, Dept. El Cauca, Colombia, alt. 3000–3300 m., distributed by the Bentham Trustees as number *1186*, and deposited in the herbarium of the New York Botanical Garden (also G).

17. B. GLABRATA (H.B.K.) Benth. & Hook.; B. D. Jackson, Ind. Kew. **1**: 361. 1895.

Lobelia glabrata H.B.K. Nov. Gen. & Sp. **3**: 307. 1818.
Siphocampylus glabrata G. Don, Gen. Syst. **3**: 702. 1834.
Centropogon glabratus Planch. & Örsted, Vidensk. Meddel. **1857**: 157. 1857.

Colombia: *Bonpland* (type, P), near Bogota, alt. 1650 m.; *Pennell 2392*, moist forest, El Peñon, southwest of Sibate, Dept. Cundimarca, alt. 2800–2900 m., 13 Oct. 1917 (Y).

18. CENTROPOGON RUBROSEPALUS Wimmer, Repert. Spec. Nov. **19**: 252. 1924.

Ecuador: near Quito. Not seen: according to the original description apparently related to *B. glabrata*.

19. B. LACERATA Karst. Linnaea **28**: 445. 1856.

B. ceratocarpa Zahlbr. Repert. Spec. Nov. **13**: 534. 1915.

Colombia: *André 3046* (K); *Linden 1071*, Quindio (P, probably the type); *Pennell 10,323*, clearing, Rio San Rafael, below Cerro Tatama, Dept. Caldas, alt. 2200–2400 m., 7–11 Sept. 1922 (Y), *10,421*, along stream in forest, alt. 2500–2800 m., same locality and date (Y), *5148*, forest, La Cumbre, Dept. El Valle, alt. 1800–2100 m., 7–10 May 1922 (Y); *Pennell & Killip 5773*, forest above La Cumbre, alt. 1800–2100 m., 14–19 May 1922 (Y); *Killip & Hazen 11,164*, forest, La Cumbre, alt. 1700–2100 m., 9 Sept. 1922 (Y); *Pennell & Killip 7229*, wooded vale west of Rio

Sucio, Dept. El Cauca, alt. 1500–1600 m., 27 June 1922 (Y), *7240*, hillside thickets east of Rio Ortega, Dept. El Cauca, alt. 1500–1700 m., 27 June 1922 (Y), *8063*, along stream, Rio Ortega, north of Tambo, alt. 1900–2100 m., 2 July 1922 (Y); *Killip 7770*, forest, "La Gallera" Micay valley, Dept. El Cauca, alt. 1400–1500 m., 29–30 June 1922 (Y), *7942*, forest, "La Gallera," alt. 1900–2000 m., 1 July 1922 (Y), *7955*, same place and date, alt. 2000–2200 m., (Y), *7862*, open land west of Rio San Joaquin, Dept. El Cauca, alt. 1400–1500 m., 29–30 June 1922 (Y); *Lehmann B. T. 1074*, Popayán (Y), *B. T. 1076*, Capilla, near Popayán, Dept. El Cauca (Y), *5767*, Couga, western Andes of Popayán, alt. 1700–2100 m. (duplicate of type of *B. ceratocarpa*, Y). Ecuador (?): *Spruce 5376* (K).

The species presents a considerable variation in foliage, as might be expected from so common a plant.* Zahlbruckner's *B. ceratocarpa* seems to be only a somewhat xerophytic form.

20. B. SYLVICOLA Zahlbr. Repert. Spec. Nov. **13**: 532. 1915.

Colombia: *Lehmann 2990*, dense humid forests of the Cordillera occidental, in the heights of Cali, Dept. El Valle, alt. 2000 m. Not seen: according to the original description apparently related to *B. lacerata*.

21. **Burmeistera carnosa** n. sp. Stem herbaceous, minutely puberulent with appressed hairs when young, glabrescent with age, persistently and densely pubescent at the base of each peduncle, the internodes 10–15 mm. long; petioles stout, 8 mm. long, essentially glabrous, strongly channeled above; leaf-blades elliptic-oblong, thick and somewhat fleshy, dull green, frequently tinged with red beneath or at the margin, the largest 13 cm. long, 4.5 cm. wide, the upper smaller, short-acuminate, broadly cuneate to subrotund at base, glandular at the margin, the glands (about 4 per centimeter of margin) occasionally protuberant

*Editor's note. In view of Dr. Gleason's characterization of *G. lacerata* as "so common a plant," it is a matter of surprise and disappointment to the editor, as a member of the Co'ombian Expedition of 1922, that this species was not found by us in the type region, the Quindio, where much time was spent in intensive collecting. It is even more disappointing that though two members of the Expedition, in going over the Old Quindio Trail to Ibagué, passed through "La Pamilla," the type station for Karsten's unknown *B. ibaguensis*, no *Burmeistera* was found on that trip. This failure can hardly be ascribed entirely to the fact that this genus is characterized by inconspicuous green flowers.

into low teeth, glabrous above, minutely puberulent on the purplish veins beneath, the veinlets prominently reticulate; peduncles from the upper axils, stout, divergent, glabrous, 4–5 cm. long; hypanthium subglobose, 5 mm. high, glabrous; sepals widely spreading or somewhat reflexed, linear, 13–18 mm. long, glabrous, finely veined, acute, frequently purple at the margin or base, with 3 or 4 pairs of minute teeth; corolla glabrous, the tube 8 mm. long below, 13 mm. above, lateral lobes broadly triangular-falcate, 8 mm. long, upper lobes linear-falcate; filament-tube minutely puberulent, 23 mm. long; anther-tube 6 mm. long, glabrous, villous at the orifice; fruit subglobose.

Type, *Pennell & Killip 7325*, from a wet glen in the forest, "San Jose," San Antonio, Dept. El Cauca, alt. 2400–2700 m., 28 June 1922, deposited in the herbarium of the New York Botanical Garden. Other collections from Colombia are *Pennell 4384*, forest above Cascada Chorron, south of Antizales, Dept. Bolivar, alt. 2400–2700 m., 25 Feb. 1918 (Y), *9405*, wet place, edge of forest, "Pinares," above Salento, Dept. Caldas, alt. 2700–2900 m., 2–10 Aug. 1922 (Y), *12,142*, shrub zone, Mount E' Truena, Dept. El Cauca, alt. 2700–3000 m., 29–30 June 1922 (Y).

22. **Burmeistera asclepiadea** n. sp. Stem suffrutescent, glabrous, ridged, the internodes about 8 cm. long; petioles stout, glabrous, 10–12 mm. long; leaf-blades deep green, thin, broadly ovate-oblong, the largest 14 cm. long, 7.5 cm. wide, the upper smaller, abruptly short-acuminate, broadly rounded or subcordate at base, entire, but with intramarginal callosities (1–2 per centimeter of margin), glabrous above, very minutely puberulent beneath; peduncles from the upper axils, slender, divergent, glabrous, 5–6 cm. long when fully grown; hypanthium subglobose, glabrous, faintly ribbed, 5 mm. high; sepals widely spreading or partly reflexed, green, linear, 15 mm. long, 2 mm. wide, obtuse, entire, with a few intramarginal callosities, glabrous, inconspicuously 3-nerved; corolla glabrous, the tube 16 mm. long above, half as long below, the lobes narrowly triangular-falcate, the terminal 14 mm. long; filament-tube 30 mm. long, sparsely subtomentose with gray hairs; anther-tube stout, 5 mm. long, gray, thinly puberulent; fruit apparently globose.

Type, *Rusby & Pennell 793*, collected in a forest at "Balsillas," on the Rio Balsillas, Dept. Huila, Colombia, alt. 2100–2200 m., 3–5 Aug. 1917, and deposited in the herbarium of the New York Botanical Garden. A second specimen is *Rusby & Pennell 681*, forest, Cordillera oriental, east of Neiva, Dept. Huila, alt. 2200–2500 m., 1–8 Aug. 1917 (Y).

Burmeistera acuminata Karst. Linnaea **28:** 445. 1856, *B. ibaguensis* Karst. *l. c.* 444, and *B. pomifera* Karst. *l. c.* 445, were briefly and inadequately described and are unknown to me. *B. tomentosula* Karst. (*l. c.* 445) also has not been seen by me, but is supposed from the description to belong to the genus *Centropogon*, section *Burmeisteroides* (cf. Bull. Torrey Club **51:** 447. 1924.).

The genus Hymenopappus in Colorado

GEORGE E. OSTERHOUT

The genus *Hymenopappus* is a difficult one to study because the characters by which the several species are distinguished are not directly evident. There is a great similarity in the heads of flowers and in the foliage. Hence the achenes and the florets have been carefully examined for characters by which to group the species. The following synopsis has little of originality in it, but the grouping of the species differs from the manner in which it has been customary to arrange them, and is offered as a study in the genus.

1. Throat of the corolla campanulate, 1.5–2 mm. long.
Paleae of the pappus very short and hidden by the achene, or none ..... 1. *H. luteus*
Paleae of the pappus shorter than the corolla tube—about half its length—not hidden by the hairs of the achene.
A biennial with creamy white flowers ..... 2. *H. tenuifolius*
A perennial with yellow flowers; heads smaller and more numerous ..... 3. *H. polycephalus*

2. Throat of the corolla cylindrical, 2.5–4 mm. long.
Paleae of the pappus equalling the corolla tube, or nearly so.
Throat of the corolla 2.5–3 mm. long; stem leafy ..... 4. *H. arenosus*
Throat of the corolla 3–4 mm. long; stem scapose ..... 5. *H. nudatus*

1. HYMENOPAPPUS LUTEUS Nutt. Trans. Am. Phil. Soc. **7**: 374. 1841.

Dr. Gray (Syn. Fl. N. Am. **12**: 336. 1884.) made *H. luteus* a synonym of *H. filifolius* Hook., and so far as the plants of Colorado are concerned this might be all right. Some of the plants are tomentose and some are not, but they are nearly of the same size and the flowers and achenes are alike. But I hesitate to make *H. luteus* the same as the *H. filifolius* of the northwest—Oregon, Washington, and Idaho. The type locality of *H. filifolius* is the Columbia River valley, though it has been said to range from Montana through Kansas, Nebraska, and Colorado to New Mexico, but I have seen no specimens from these states and I suspect it has been confused with other species. In describing *H. cinereus* Dr. Rydberg observed: "This species has

been confused with *H. filifolius* and *H. flavescens*. . . .The species is, however, much nearer related to *H. filifolius* from which it differs mainly in the lower habit and the longer scales of the pappus." Specimens of *H. tenuifolius* have also been listed as *H. filifolius*. My collections of *H. luteus* were made from locations west of the mountains, from the vicinity of Craig in Moffat County. A part of the specimens are tomentose and a part are becoming glabrate.

2. HYMENOPAPPUS TENUIFOLIUS Pursh, Fl. **2**: 742. 1814.

The type locality is "In Upper Louisiana," and the specimens were collected by Bradbury in 1810. My collections were made on the plains of eastern Colorado, where it is rather common.

3. HYMENOPAPPUS POLYCEPHALUS Osterhout, Torreya **18**: 90. 1918.

In the Synoptical Flora (*l. c.*) under *H. filifolius* Dr. Gray wrote: "Northeastern forms are greener, more leafy, with smaller heads, approaching *H. tenuifolius*." I suspect the plants referred to are the above species, for Dr. Gray did not limit *H. filifolius* to plants with a very short pappus. This species is found along the eastern side of the foothills of northern Colorado and eastward into the Plains.

4. HYMENOPAPPUS ARENOSUS Heller, Bull. Torrey Club **25**: 200. 1898.

H. cinereus Rydberg, Bull. Torrey Club **27**: 634. 1900.
H. ochroleucus Greene, Pl. Baker. **3**: 30. 1901.
H. parvulus Greene, *l. c.*

In the original description of *H. arenosus* Heller wrote: "corollas 5 mm. long, the tube occupying nearly half the length, the throat cylindrical rather than campanulate, the triangular lanceolate lobes little more than one-fourth the length of the throat, achenes villous with long hairs; palae of the pappus oblong or slightly contracted below, a little longer than the corolla tube." Except for some less tomentum I think that *H. cinereus* Rydberg is the same, and *H. parvulus* Greene is only a small flowered, glabrate form. In some plants of *H. arenosus* the flowers may have campanulate corollas, but the long pappus scales easily

separate it from *H. tenuifolius*. The type locality of *H. arenosus* is "near Espanola, Santa Fé County, New Mexico," and so far as I know, it has not been found farther north than Larimer County, Colorado. It grows both on the eastern and western sides of the mountains.

5. HYMENOPAPPUS NUDATUS Wooton & Standley, Contr. U. S. Nat. Herb. **16**: 191. 1913.

The type locality of *H. nudatus* is in New Mexico, and a specimen of the type number is in the Rocky Mountain Herbarium of the University of Wyoming. It is probable that this is a synonym of *H. macroglottis* Rydberg (Bull Torrey Club **27**: 634. 1900.) which was somewhat doubtfully reported from Colorado in the original description.

I have two collections of *H. nudatus*, one made at DeBeque in Mesa County, the other made at Grand Junction in the same county. The Grand Junction specimen is tomentose, the other is becoming glabrate. Tomentum is not a good character by which to separate species of *Hymenopappus*.

The standing of *Hymenopappus filifolius*, as indicated above under *H. luteus*, is rather uncertain, and if it occurs in Colorado it would seem to be in the section west of the mountains where *H. luteus* is also found. The glabrate forms key as well into *H. filifolius* as into *H. luteus*.

Hymenopappus scaposus Rydberg (Bull. Torrey Club **27**: 634. 1900.) has also been listed for Colorado, being reported by Coulter and Nelson (New Manual of Botany of the Central Rocky Mountains 555. 1909.) as ranging from Colorado to New Mexico and Nevada; but Rydberg (N. A. Flora **34**: 53. 1914, and Flora of the Rocky Mountains 943. 1917.) still restricts the distribution of this species to Utah, Nevada, Arizona, and New Mexico, as at the time of its original description, and I have seen no specimens from Colorado.

WINDSOR, COLORADO

INDEX TO AMERICAN BOTANICAL LITERATURE
1924–1925

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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